Section 5
CALIBRATING EQUIPMENT
L Series

SECTION 5. CALIBRATING EQUIPMENT

INTERCHANGEABILITY OF LM–7, LM–10, LM–13 AND SCR–211 FREQUENCY METER CRYSTALS

Crystals installed in LM–7, LM–10, LM–13 and SCR–211 frequency meters are interchangeable after these changes in the wiring of the crystal socket are made:

(1) Solder a wire from pin #2 to pin #3.

(2) Solder a wire from pin #7 to pin #8.

On the SCR–211 crystals, pins #3 and #7 are the active terminals, #7 being grounded. On the LM series crystals, pins #2 and #8 are the active terminals, pin #8 being grounded. There is also a jumper wire between pins #8 and #6, which should remain in place. Attention is invited to the fact that the physical wiring diagram in the LM series instruction book shows a *top* view of the crystal socket X–106, rather than the bottom view presented for other sockets.

After completion of the above changes, either Navy model LM series or Signal Corps model SCR–211 crystals may be used interchangeably in the model LM series frequency meter.

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RECTIFIER 20104–A FOR LM FREQUENCY METER

During January, 1945, the Bureau has shipped for field use, under contract NXsr–71325–P (Bendix Aviation Corporation) a total of 50 rectifier power units designed for use with model LM–11 frequency meters. Distribution of these rectifiers, Navy type 20104–A, was made as follows:

10 sets to FRAY–32
10 sets to LEFT–32
30 sets to the Radio Supply Branch, Naval Supply Depot, Oakland, for Radio Material Officer's disposition.

This rectifier requires an a-c input of 105/115/120 volts, single phase, 60 cycles. Its output is 290 volts at 0.020 amps DC and 13.0 volts at 0.60 amps. AC. This rectifier is the same as the Navy type 20104 designed for use with the LM–6 except that the line voltmeter has been removed and replaced with a pilot light. The 20104–A type provides its own filament supply of 6.3 volts at 0.3 amps. AC.

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USE OF THE LM FREQUENCY METER AS A VARIABLE FREQUENCY OSCILLATOR FOR EMERGENCY FREQUENCY CONTROL

See article entitled "Emergency Frequency Control" on page GEN:36.

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→ MODEL LM SERIES FIELD CHANGE NO. 1

ADDITION OF ADJUSTMENT LEVER FOR CORRECTOR DIAL

Equipment affected.—All models of LM series.

Purpose.—To facilitate the moving of the corrector knob in small increments.

Action required.—The corrector knob should be removed from the equipment and drilled and tapped as shown in Figure 1. A brass or steel rod having the approximate dimensions shown in the figure should be threaded at one end. The adjustment lever is offset about 10° in order that the dial be visible when the corrector knob is rotated to its full counterclockwise position.

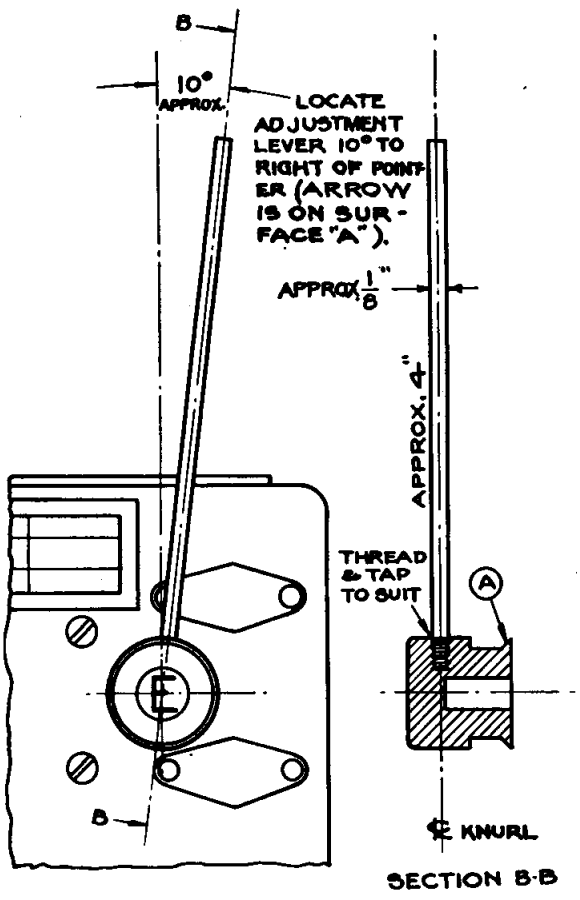

Figure 1.—Adjustment lever for corrector dial.

General.—This change is within the capacity of the ship's force. Record of this change should be made on the ship's "Radio Equipment Log" NAVSHIPS 900,039. Completion of this change should be reported on the NBS–383 failure report form. *6/1/46*

→ DISCREPANCY IN THE LM–18 INSTRUCTION BOOK

The Bureau has been informed of two errors which appear in the LM–18 instruction book NAVSHIPS 900,002. The first one is on page 17, in section V (2d) under the column V–103, which indicates the pin markings and voltages of tube V–103. The pin numbers for the filaments are incorrect, filament 1. should read 6.8AC (5) and filament 2. should read 0.0 (1). The second error appears on the schematic wiring diagram figure 20. C–110C is shown connected in parallel with C–110A while it should be connected as shown on the corrected wiring diagram given here on figure 1. *8/1/46* ←

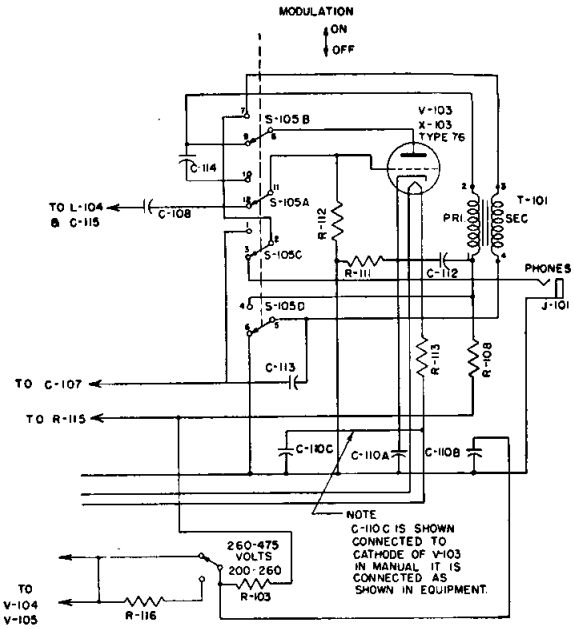

FIGURE 1.—Schematic diagram of the LM–18 frequency meter.

MODEL LM SERIES TROUBLE SHOOTING NOTES

Difficulty Encountered	Cause and Remedy
No crystal check beat notes can be heard.	Inspect contacts of octal socket into which crystal is plugged. Also check clearance between grid contact of 76 tube and metal case.
No modulation.	Audio oscillator feedback condenser C–114 shorted.—U. S. S. *Leedstown*
LM–11.—Equipment will not operate, apparently "dead."	Failure of equipment was caused by extreme heat and humidity. The rectifier voltage reading normal, but no voltage reading could be obtained at pin 26. There were no shorts on output. Inductance L–201 was found open. As a temporary means of repair, a 1000-ohm resistor was placed across the filter choke terminals. Normal operation, except for increased hum in output, resulted.—U. S. S. *Calvert*
LM–18.—Difficulty was encountered in getting the gear to operate properly.	It was noted that resistor R–103 had changed its value from 25,000 ohms to 29,000 ohms. Replaced this and the voltage regulator tubes V–104 and V–105. Also found trouble in the wiring over R–103. Gear then operated properly.—U. S. S. *Merrill* (DE–392)
→ LM–18.—No modulation. Weak beat note when checked with crystal. V–103 had plus 31.0 volts on cathode and plus 32.5 volts on plate.	Trouble found to be due to dirt on contacts of S–105D. Cleaned contacts of switch and equipment operated normally.—Ens. E. D. Knowles, U. S. S. *Devastator* (AM–318) ←

→ CORRECTION TO THE MODEL LP–5 INSTRUCTION BOOK

The instruction book for the model LP–5, NAVSHIPS 900,425 should be corrected as follows:

Page 5–10, line 7 should read "5%" instead of "50%". *3/1/46* ←

MODEL LR SERIES INTERPOLATOR DIFFICULTIES

From time to time the Bureau has received reports of drifting or instability of the interpolator on model LR series equipments necessitating frequent resetting of the interpolator alignment adjustments. The contractor has been contacted on this point and reports that no instrument serviced in the field by the contractor has exhibited such a condition of instability as to require the frequent resetting of the alignment adjustments. In every case investigation has shown that the faults were due to other than alignment adjustments and attempts to correct these other faults in this manner merely aggravated the condition.

The contractor has submitted the following comments relative to the causes of the instability:

(1) One cause for such trouble may be abnormally low line voltage combined with the fact that the line fuse in the instrument has not been moved to the low line position.

(2) The regulator tube V–118, supplying the interpolator, may fail to light at all; light when the equipment is first switched to "RUN"; or light intermittently.

(*a*) For the first condition, a tube having a high striking voltage aggravates the condition. Interchanging tubes among V–118, V–119, and V–120 will often overcome the trouble.

(*b*) Under the second condition, after the equipment is switched on, pressing the DEION-IZE switch, S–105, will cause V–118 to light, after which it operates until the equipment is switched off.

(*c*) The third condition is found where, due to large variations in supply voltage, the voltage is abnormally low—but it lights normally when the voltage rises nearer normal values.

(3) Inspection of tubes V–118, V–119, and V–120 to see that they ALL are lighted should be the first check, if normal interpolator readings are not obtained. If the supply voltage is low, move the line fuse to the low-voltage position.

(4) Occasional trouble may be experienced when interpolator alignment adjustments have been disturbed upon handling of the equipment. *If the handle provided at the left hand rear of the frame will be used* (instead of grabbing the interpolator shelf as a handle) *this trouble will be avoided.*

(5) A small fluctuation in interpolator readings (of the order of 0.25 divisions in range) as a function of line voltage variations is unavoidable. In normal equipments this is caused principally by changes in the resistance of the type 84 rectifier. The condition can be aggravated by poor type 884 gas triodes, which *infrequently* are sensitive to small changes in heater temperature.

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FREQUENCY MEASUREMENTS USING MODEL LR–1 FREQUENCY METER

Cheltenham measures the frequencies of all circuits handling traffic with the Navy Department. For this purpose we use an LR–1 frequency meter and exercise extra precautions to insure better than average accuracy for this type of equipment.

The crystal standard in the LR–1 has been found to be very stable over long periods of time, the error seldom exceeding 10 cycles at 5,000 kc. when the calibrator output is checked direct with WWV. However, the accuracy of measurement in the LR–1 is most likely to be affected by error in interpolation. As you know, the LR–1 uses an electronic counting device or audio-frequency beat-note indicator to determine the difference in frequency of the heterodyne oscillator (set to zero-beat with the station being measured) and a harmonic of the crystal calibrator. The error in such a device is usually somewhat less than 2 percent of full-scale deflection or in the neighborhood of 100 cycles on the black scales or 200 cycles on the red scales. We have found that the gas trigger tubes (884's) in the counting circuit are somewhat overworked and accordingly their characteristics become rather erratic after even short periods of use. This period, of course, varies somewhat with individual tubes. By making frequent checks of interpolator operation as outlined in our instructions, however, we have been able to ascertain when the tubes are beginning to fail and correct the trouble before serious errors occur.

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In measurement of frequency-shift circuits it has been only in instances where a frequency-shift signal is not "clean" or has "phase modulation" (intentional, or improper adjustment) impressed on it that any particular difficulty is encountered. Normally a zero-beat may be obtained on the MARK signal and/or the SPACE signal with little more difficulty than that incurred in taking a measurement on two separate stations operating about a kilocycle or so apart. The "carrier" frequency is then considered as being the mean of the MARK and the SPACE measurements, and the standard tolerance is applied to this value.

At high keying speeds it is more difficult to distinguish the condition of zero-beat since we have to contend with the audio component of the keying speed but with some experience an operator can obtain very satisfactory measurements in spite of the keying speed.

Annapolis manages to keep the various transmitters for the most part within the 0.005 percent tolerance by measurement with an LR–1. A 3″ oscilloscope is used with the LR–1, having the vertical plates in parallel with the headphones. This allows the various operators to visually observe the picture of several cycles shown on the screen becoming a straight horizontal line as zero beat is reached. The differences in hearing which can effect zero beat settings and readings are thus minimized. As at Cheltenham, recurrent trouble with the interpolator meter of the LR–1 has been experienced. The root of the trouble is the aging of the 884 Thyratron tubes. If not checked at intervals several hundred cycles error can exist without being immediately apparent to the operator.

At Annapolis, accurate zero beats for high speed keying are not easily made when depending on aural reception only, due to the ear being unable to hear "zero beat" in the presence of key clicks associated with high speed keying. However, the vertical plates of an oscilloscope in parallel with the phones will permit visual observation of zero beats for visual measuring purposes irrespective of keying speed.

Our routine includes inspection of master-oscillator oven thermometers at hourly intervals to see that no drift occurs due to malfunction of heater circuits.

We have found that the master-oscillator frequency on some transmitters varies as much as several hundred cycles when the switch is thrown from normal to F/S keying. Determination of the cause of this change is currently being investigated but no conclusion has yet been reached. However, until definite conclusions can be reached, our practice is when setting up a new frequency employing F/S, to set the frequency meter at the assigned frequency plus 425 cycles, retrimming the master-oscillator as necessary to obtain zero beat. This insures that the mark and space frequencies are symmetrically disposed, entered on the assigned frequency.—*W. C. S.*, USN Radio Station, Cheltenham, Md.

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ERROR IN THE INSTRUCTION BOOK FOR MODELS LR AND LR–1 HETERODYNE FREQUENCY METERS

The U. S. S. *Ammen* (DD–527) has invited the attention of the Bureau to an error in certain of the instruction books for the models LR and LR–1 heterodyne frequency meters. In these books, paragraph 5.5261 contains the word "counterclockwise" which should be changed to read "clockwise." Paragraph 5.5261 (*b*) should have sentence five changed to read "with a high resistance voltmeter, connected between the clockwise end of R–175 (located at center of lower left-hand shelf) and the arm, adjust R–175 to obtain a reading of 5.0 volts."

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DEFECTIVE DIALS IN MODELS LR–2 EQUIPMENTS

Chief radio-electrician Weaver of the U. S. S. *Nashville* has reported to the Bureau a defective marking on the dial N–103 in the model LR–2 heterodyne frequency meter, serial No. 28. The difficulty was such that a 100-kc. error in frequency measurement could have been easily possible.

The defective section occurred on the 10th band where the scale was marked "4.45—4.6—4.55—4.6—4.65" where the actual calibration should have read "4.45—4.5—4.55—4.6—4.65."

The defective marking was corrected by erasing the incorrect 6 and inking in a 5.

All ships and stations having model LR series equipments should make a close inspection of the dials for similar errors as this is one of several isolated cases of incorrect dial marking reported to the Bureau.

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MODEL LR SERIES TROUBLE SHOOTING NOTES

Difficulty Encountered	Cause and Remedy
Interpolation meter not operating properly.	Defective 884 tubes. Replaced.—U. S. S. *Nitro*
LR–1.—Ser. 97. Interpolator not operating properly.	Vacuum tubes VT116 and VT115 replaced.—U. S. S. *Indiana*
High hum level in headphones when checking against calibrator.	Caused by open grid circuit in type 76 multivibrator output amplifier tube.
Steady audio tone in headphones with regular beats against calibrator heard in background.	Caused by improper bypassing in audio amplifier due to open common ground return of bypass condenser bank in audio amplifier. Condensers are mounted on power supply shelf.
No normal beat tones when checking against calibrator; steady very-low-frequency popping or motorboating.	Caused by shorted diode detector. Usually traced to bus leads at front of type 75 diode detector and a-f amplifier shorting together.
No audio output.	Caused by a shorted plate voltage supply to detector and audio-amplifier shelf. Usually caused by the heavy shielded cables pulling down the B+ supply bus wire at left under side of shelf thus shorting the plate supply voltage. Replace bus bar with insulated wire.
High hum level in audio output. Abnormal heating of hum control resistor, R–183.	Caused by ground on one side of heater circuit of tubes.
Low audio output.	Caused by poor detector tube, type 75 (V–106).
Noisy audio output when making zero beat settings.	May be due to either external noise pickup or a faulty detector tube. Remove coupling lead and if noise continues try replacing the type 75 detector tube (V–106).
Buzz in audio output; sounds like r-f hash from mercury vapor rectifier.	Due to sparking in rectifier buffer condensers. If a poor connection exists in condenser C–161, C–162 or C–190, sparking may take place across the gap causing the noise. Such a condenser will not show leakage when tested under high voltage.
Noise in audio output.	Probably due to poor contact in filter and audio bypass condensers on bottom shelf. Check all connections and condensers for poor joints. Resolder as required.
Heterodyne frequency meter. Calibration does not agree with crystal calibration.	Due to multivibrator out of control. Reset calibrator adjustments according to instructions in instruction book. This condition may also produce unsteady beat notes and/or wobbly reading of interpolator meter.
Erratic operation of interpolator meter. Reads OK if DEIONIZE switch is pressed and released after switching instrument on.	Caused by improper plate supply voltage to the interpolator shelf. Check type VR–105–30 voltage regulator tube (V–118). This is best done by replacement with a new tube. The tube glows on first switching instrument on, then goes out as the tubes warm up (normal), but fails to light up again unless DEIONIZE switch is depressed and released. Also check lead from power plug P–101 (lower left-hand corner of panel). This bears against R–172 (wire-wound resistor ferrule type, 6 watts) on front lower side of interpolator shelf, grounding R–172.

Interpolator meter does not operate with scale selector switch in upper position.	Caused by resistors R–173 and R–175 shorted by bare bus bar being bent in handling. This lead is located at left of instrument near latch bar.
Interpolator meter snaps off scale on approaching zero beat by the heterodyne frequency meter for crystal calibrator.	Caused by 10-kc or 20-kc signals passing through audio filters. Audio filters LC–101 or LC–102 are defective. This fault may be quickly detected by putting the HFM RANGE SELECTOR switch on a dead point. Set CALIBRATOR to 10 kc and then to 20 kc. If interpolator reads off scale instead of zero, one of the filters is faulty. Using a cathode-ray oscilloscope check the input and output voltages of each filter, setting the gain adjustments of the oscilloscope to get a good deflection on the input voltage. If the filter is normal, there will be no noticeable deflection on the output voltage with the same gain. Troubles with filters may usually be traced to an open condenser.
Erratic operation of the interpolator meter or a steady reading at about mid-scale.	Caused by grounded interpolator meter. Usually due to shield can of the type 83 mercury vapor rectifier on top of shelf touching the interpolator meter minus terminal. Suitable insulation should be provided to prevent recurrence of this difficulty.
Interpolator meter reads about 1/5th of full scale continuously with SCALE SELECTOR switch in lower position.	Caused by lack of bias voltage due to open circuit in DEIONIZE switch or other failure in voltage supply to interpolator shelf.
Interpolator meter reading erratic. Reading mid-scale at zero beat or with no signal gives small change in reading for a 5-kc change in input frequency.	Check for open at one end of R–175 (5000-ohm 6-watt rheostat).
Crystal oscillator plate current very low. (About 0.6 milliamps).	Caused by low plate voltage to calibrator shelf. Check C–120 (a variable condenser) for short. This shorts the plate supply through R–16.
Heterodyne frequency meter does not oscillate.	Check for ground on bus leads from coil assembly through top shelf.
Erratic oscillation of heterodyne frequency meter on ranges 10 and 12.	Check for loosened solder joint in L–106. Remove can and resolder joint which is inside lip of coil form.
Heterodyne frequency meter calibration does not agree with calibrator on two ranges.	Check for loosened coil wires causing change in inductance.
Line fuse blows on turning switch from STAND BY to OFF.	Caused by high voltage lead to C–185 or other power filter condensers being very near to ground. Arc is formed under high voltage but will not show ground with ohmmeter.
Line fuse blows on turning to STAND BY from OFF.	Check buffer condensers C–192A and C–192B for short circuits. Also check these condensers with megger or other high voltage source for breakdown under high voltage.
Heterodyne frequency meter plate current is higher than normal, 1½ milliamps on range one. Also frequency on range one is higher than normal.	Check C–134 or C–136 for open circuit. The oscillator is oscillating on stray capacity. Frequency error will be greater at low frequency end, decreasing at high frequency end.

No heterodyne frequency meter output on high frequencies (15 to 30 megacycles).	Caused by defective oscillator grid leak R–137. The resistance often increases from the normal 100,000 ohms to nearly 1 megohm.
LR–1.—Calibrator unit inoperative. Excessive current reading obtained in crystal oscillator meter M–102.	The resistance between meter and ground was 200 omhs. By tracing through the circuit, a break-down was discovered in the crystal oscillator screen bypass capacitor C–108. This is the decoupling capacitor in the screen grid circuit of oscillator tube V–101. When C–108 was replaced, the equipment returned to normal operation.—U. S. S. *Thomas E. Frazer*
LR–1.—Interpolator fails to work on the 10- and 20-kc. scale. Operation normal on the 100-kc. scale.	Examination of interpolator stages shows no plate voltage on tube V–105. Shows reading direct to ground. Trouble found in tube socket which developed a ground between the mounting screw and the plate connection due to excessive use of solder. Connection soldered properly—operation normal.—U. S. S. *Solomons* (CVE 67)
LR–1.—Power supply voltage too low and line fuse frequently blowing.	The lugs on the power supply leads were too long and had become partially grounded.—U. S. S. *Commencement*
LR–1.—Unable to couple r. f. energy from transmitter to frequency meter through the r. f. input jack.	Found RV–34 open. Replaced and all O. K. again.—U. S. S. *Versole* (AD–878).

INSTRUCTION BOOK FOR MODELS LAF AND LAF–3 R–F SIGNAL GENERATOR EQUIPMENTS

The instruction book for models LAF and LAF–3 R–F Signal Generator Equipments (NAVSHIPS 900, 516) contains an error in the titles of tables 8–2 and 8–3. Table 8–2 should be entitled "Combined Parts and Spare Parts List by Symbol Designation for Model LAF Signal Generator." Table 8–3 should be entitled "Combined Parts and Spare Parts List by Symbol Designation for Model LAF–3 Signal Generator." The titles were inadvertently reversed in printing, although the Table of Contents shows the correct titles. Pen and ink corrections should be made to copies already in the field.

This instruction book supersedes the *Preliminary Instruction Book for Navy Model LAF Signal Generator* (Contract Number NXsr–39273) and *Preliminary Instruction Book for Navy Model LAF–3 Signal Generator* (Contract No. NXsr–53363). The final book is available and should be requisitioned in the usual manner if only the preliminary books are on board. *4/1/49*

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INFORMATION ON MODEL LRN SERIES EQUIPMENTS

For information on model LRN series equipments look on the pages for the model DAS series equipments.